NAVAL POSTGRADUATE SCHOOL

Monterey, California

THESIS

A CASE STUDY
OF THE LOGISTICS SUPPORT OF
THE AN/SLQ-32 ELECTRONIC WARFARE SYSTEM

by

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December 1985

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REPORT DOCUMENTATION PAGE

REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; Distribution is unlimited
DECLASSIFICATION/DOWNGRADING SCHEDULE	
ERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
NAME OF PERFORMING ORGANIZATION al Postgraduate School — 6b. OFFICE SYMBOL (If applicable) 54	7a. NAME OF MONITORING ORGANIZATION Naval Postgraduate School
ADDRESS (City, State, and ZIP Code) terey, California 93943-5000	7b. ADDRESS (City, State, and ZIP Code) Monterey, California 93943-5000
NAME OF FUNDING/SPONSORING ORGANIZATION — 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
ADDRESS (City, State, and ZIP Code)	10 SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

TITLE (Include Security Classification) A CASE STUDY OF THE LOGISTICS SUPPORT OF THE AN/SLQ-32 CTRONIC WARFARE SYSTEM

PERSONAL AUTHOR(S) MCILRAVY, Thomas P.

TYPE OF REPORT	13b TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
ter's Thesis	FROM ______ TO ______	December 1985	58

SUPPLEMENTARY NOTATION

COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	AN/SLQ-32, Maintainability, Logistics Support, Supportability, Reliability

ABSTRACT (Continue on reverse if necessary and identify by block number)

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DISTRIBUTION/AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION	
NAME OF RESPONSIBLE INDIVIDUAL R. D. Evered	22b. TELEPHONE (Include Area Code) 408-646-2646	22c. OFFICE SYMBOL 54Ev

FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

A Case Study of the Logistics Support of the AN/SLQ-32 Electronic Warfare System

by

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Lieutenant United States Navy
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Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
December 1985

ABSTRACT

The trade-offs made by a Program Manager in a weapon system program are frequently at the expense of logistics support. This thesis is a case study of the logistics support of an electronic warfare system program, designated AN/SLQ-32. The AN/SLQ-32 Program provides an example of the classic problems that result when logistic planning is neglected and underfunded in a weapon system program. The initiatives taken by the Navy to correct the logistic problems of the AN/SLQ-32 are presented with respect to their impact on two measures of effectiveness; Operational Availability and Systems Material Availability. The research concludes that to ensure a weapon system will meet its Operational Availability goals there must be a sound logistic support plan established early in the program and it must be strictly adhered to and monitored.

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LIST OF ABBREVIATIONS

AE	Ammunition Ship
AFS	Combat Stores Ship
AGF	Miscellaneous Command Ship
Ao	Operational Availability
AO	Oiler
AOE	Fast Combat Support Ship
AOR	Replenishment Oiler
BB	Battleship
CASREPT	Casualty Report
CG	Guided Missile Cruiser
CGN	Guided Missile Cruiser (Nuclear)
CNM	Chief Naval Material
CNO	Chief Naval Operations
COSAL	Coordinated Shipboard Allowance List
DD	Destroyer
DDG	Guided Missile Destroyer
DLS	Decoy Launching System
DOP	Designated Overhaul Point
DTP	Design-To-Price
ESM	Electronic Support Measure
EW	Electronic Warfare
FF	Frigate
FFG	Guided Missile Frigate

ICP	Inventory Control Point
ILS	Integrated Logistics Support
LAR	Logistic Assessment Review
LCC	Amphibious Command Ship
LHA	Amphibious Assault Ship (General Purpose)
LKA	Amphibious Cargo Ship
LPD	Amphibious Transport Dock
LPH	Amphibious Assault Ship (Helicopter)
LRG	Logistic Review Group
LSD	Dock Landing Ship
MLSF	Mobile Logistics Support Force
MSD	Material Support Date
MSRT	Mean Supply Response Time
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
NAVELEX	Naval Electronic Systems Command
NAVELEDETMECH	Naval Electronic Systems Command Detachment Mechanicsburg
NAVMAT	Naval Material Command
NAVSUP	Naval Supply Systems Command
NRFI	Not Ready For Issue
NSF	Navy Stock Fund
OBRP	On Board Repair Parts
OPNAV	Office Chief Of Naval Operations
PM	Program Manager
PPL	Provisioning Parts List

PSICP	Program Support Inventory Control Point
PTD	Provisioning Technical Documentation
RFI	Ready For Issue
SDT	System Diagnostic Testing
SOT	System Operability Tests
SMA	System Material Availability
SPCC	Ships Parts Control Center

I. INTRODUCTION

A. BACKGROUND AND RESEARCH QUESTION

This thesis is a case study of the logistic support problems of an Electronic Warfare System Program, designated as the AN/SLQ-32. The AN/SLQ-32 Program was selected for this thesis because it provides an example of the classic problems that result when logistic planning is neglected in a weapon system program. The presentation of these logistic problems, along with the initiatives that were taken to correct them, provides a vehicle for learning and understanding the basic need for logistic planning and the importance of reliability, maintainability and supportability on life cycle support.

The AN/SLQ-32 Program experiences severe logistic support problems, primarily in the key areas of reliability, maintainability and supportability. These three areas are components of Operational Availability (Ao), which is a measure of the degree to which the AN/SLQ-32 is in the operable and commitable state when the mission is randomly called for [Ref. 1]. Simply stated, Operational Availability (Ao) is a ratio of a weapon system's operating time to its downtime.

Supportability is the evaluated component of System Material Availability (SMA). Systems Material Availability

is a Navy supply system wholesale measure of the Navy's inventory control point. It is defined as a percent of requisitions that are satisfied on the first pass against supply system assets. The SMA performance measure is an indication of the Navy's ability to provide supply support to a weapon system. It is the unacceptablly low Ao and SMA levels experienced by the AN/SLQ-32 that gives the system its notoriety and spotlights its logistic deficiencies.

The research question of the thesis is "What Are the Supply Support Problems of the AN/SLQ-32 Program and How is the Navy Solving These Problems With Respect to Operational Availability (Ao) and Systems Material Availability (SMA)."

The research question highlights the impact of poor logistic planning on the life cycle support of the weapon system. Logistic planning is an important, but often neglected, part of a weapon system program. A Logistic Plan philosophy is to provide the least cost logistic support that is fully responsible to the life cycle requirements that are imposed by equipment design, use, mission and the operational environment. There are many different methods that a logistic plan can follow. In the AN/SLQ-32 Program, two methods in particular, the Design-To-Price (DTP) contracting method and a very contractor-dependent interim support philosophy, were instrumental in influencing its early logistic planning and decision making. These two philosophies, along with funding priority deficiencies will

be presented in this thesis as the events that most influenced the AN/SLQ-32 Programs logistic support problems. The thesis presents the logistic problems that the AN/SLQ-32 Program experienced and how they effect reliability, maintainability and supportability.

The logistic problems that the program experienced were of such magnitude that in order to provide the system with some effective support, the Navy ended the interim contractors support period early and accelerated the transition to Navy support. The system's early transition and significant logistic deficiencies presented the Navy with a situation that required bold corrective initiatives. The initiatives taken were not temporary corrective measures but instead were well thought out, intensively managed measures that sought to remedy the problems and not just the symptoms. The initiatives are presented with respect to how they impact the functions of reliability, maintainability and supportability. By doing this the reader will be given an understanding and an appreciation of the reasons for selecting the initiatives.

B. APPROACH

The initial thrust of this thesis is to provide a case study of a weapon system that experienced severe support problems and research the reasons for the problems and the initiatives taken to solve them. The AN/SLQ-32 program was selected for two reasons. First it provided many examples

of the consequences of poor logistic planning. Second, the initiatives that were used are good examples of the organized effort that is required to improve system support.

Data and information were obtained from the organizations involved in the AN/SLQ-32 program. The Space and Warfare Command (formerly Naval Electronics Systems Command)code, PME-107, the Program Manager and code 08, the Logistics Managers, were two of the sources of information for this research. These two codes provided information on the programs Integrated Logistic Support (ILS) plan, the Logistic Assessment Reviews (LAR) and the current status of their initiatives. The Naval Supply Systems Command, code 03, Fleet Support, provided information on the Detection Action Response Team (DART) and background on the accelerated transition decisions. The contractor, Raytheon in Goleta California, was able to provide information on the original contract. The Inventory Control Point (ICP), Ships Parts Control Center, Mechanicsburg, Pa., provided the updated information relating to the initiatives taken and their effects on Operational Availability and System Material Availability. Most of the information gathered for this research was from the files of the three Navy commands that were previously mentioned. The early history and background was obtained through interviews with people involved in the program's early phases and from members of the transition support team. This thesis assumes some basic

knowledge of the different phases of weapon system acquisition. [Ref. 2]. The thesis completed by LT. Michael F. Sule [Ref. 3] will aid in understanding the NAVELEX method of planning for follow on spare support.

C. ORGANIZATION

Chapter II provides the background and history on the need for an Electronic Warfare Countermeasure System and the evolution of the AN/SLQ-32 to fill that need. The background and history details the many logistic support problems that the system experienced. Chapter III introduces Operational Availability (Ao) and System Material Availability (SMA). These are two measures by which weapon system support is evaluated. The chapter then attempts to provide an understanding of how each initiative that was taken effected the different parts of the Ao and SMA equations. Chapter IV provides a summary and conclusion describing several of the lessons learned from the program and some of the problems that still exist.

II. BACKGROUND AND HISTORY

A. INTRODUCTION

The purpose of this chapter is to explain the need for a new Electronic Warfare System for surface ships and to address the factors leading to the design -to-price concept. Emphasis is placed on the design-to-price concept's key objectives and their effect on the AN/SLQ-32, the electronic warfare system that was developed under this concept. The AN/SLQ-32 history is presented with emphasis on its policy of total contractor support and the supply support problems that this presented.

B. SYSTEM DESCRIPTION

The AN/SLQ-32 is a major electronic warfare system. It is provided in three operational configurations or variants, designated (V)1, (V)2, (V)3 and one training configuration designated (V)T1. Each operational variant provides Electronic Support Measures (ESM) in the form of detection, identification and bearing of Radar Frequency (RF) emiters in one or more of the three designated frequency bands, and each provides a Decoy Launching System (DLS) control. The (V)1 is the basic ESM equipment and provides frequency coverage in the high threat band 3 spectrum only. The (V)2 configuration expands the frequency range to a wide band coverage by the modular addition of two receivers covering

bands 1 and 2. Further expansion in functional capability is achieved in the (V)3 variant through the addition of an Active Electronic Countermeasure (AECM) capability. [Ref. 4]

The basic functional capabilities of each variant and the type of ships in which it will be installed are shown in Figure 2.1

Variant	Capabilities	Platforms
(V)1	-Band 3 receive -Super Rapid Blooming Offboard Chaff (SRBOC) Launching Capability	AE, AFS, AGF FF, LKA, LPD, LSD
(V)2	-Bands 1,2 and 3 receive -SRBOC Launching capability	DD, DDG, FF, FFG
(V)3	-Bands 1,2 and 3 receive -SRBOC Launching Capability -Band 3 AECM Capability	AOE, AOR, BB, CG, CGN, LCC, LHA, LPH

Figure 2.1 Functional Capabilities and Platforms.

C. DESIGN-TO-PRICE ELECTRONIC WARFARE DEVELOPMENT

The need for an electronic warfare system for ships' self defense against missiles was recognized prior to 1960. In the 1960's new technologies inspired research and

development in the area of electronic warfare (EW). The project that explored the use of these new technologies for EW was a project was called SHORTSTOP EW and it developed some very effective systems, but their costs were prohibitive. Modifications to improve the capabilities of existing systems had been developed and procured, but the inherent limitations of the original design prevented enhancement of their capabilities to the degree necessary to meet the threat. The Navy was prompted in 1971 to introduce a new program approach which was designed to produce a family of modular electronic warfare system components from which suitable configurations for a wide range of ships could be obtained at an affordable cost. A need still existed to replace the antiquated and inadequate AN/WLR-1 receiver and An/ULQ-6 repeater in the fleet and to provide up to date capabilities for new construction ships. The only other systems available at that time (AN/SLQ-17 and AN/WLR-8) were also unaffordable for the 300 or so ships that needed new systems. The new program was a competitive development of production prototype equipments which were to be designed to meet predetermined production prices. [Ref. 5:p.B1]

In May 1972, the Chief of Naval Operations (CNO), authorized the Chief of Naval Material (CNM) to initiate , in FY73, development of a low cost electronic warfare suite modularized in such a way that a maximum number of platforms, including surface and aircraft, could be outfited for

a passive Electronic Warfare (EW) capability, using common components, and larger ships could be given greater capability by adding active components to the system. Three cost levels were established, ranging from $300,000 to $3,000,000 for a unit production, initial support, and installation costs. [Ref. 5:p.2.3]

The systems to be developed were to be modularized to provide three levels of capability, suited to three sizes of ships. The lowest cost system would monitor the RF bands of highest interest and provide automatic detection, identification, and bearing information on approaching anti-ship missile threats. The cost of this system, designated (V)1, was set at $300,000 each, including support equipment, initial spare parts, and installation in 116 Fast Frigate (FF) size ships.

The second or (V)2 system would consist of the (V)1 unit with added receivers, antennas and a larger threat library, to enable detection and identification of more emiters, particularly those associated with anti-ship missile platforms. The produced and installed cost was set at $500,000 based on installation in 118 ships of Destroyer (DD) size.

The third, or (V)3, system would consist of the (V)2 units with an active Electronic Countermeasure (ECM) system capability added, capable of automatically generating an appropriate jamming or deception signal against a large number of threat emiters simultaneously . It was priced at

$ 1,400,000 per system installed in 59 ships of Guided Missile Cruiser (CG) or larger size. [Ref. 5:p.5] The essential feature of this development was that the production price levels were to be considered non-negotiable, and contractors were to compete to provide the best overall anti-ship missile defense capability they could for the price. The contractors were provided a list of desired capabilities, descriptions of shipboard environment, and descriptions of battle scenarios in which the system must be effective. Provided certain minimum requirements were met, they were free to make tradeoffs among the various specific performance characteristics (sensitivity, power, accuracy, speed, etc.), reliability, availability, and operating and support costs. At the completion of the engineering development phase, the competing systems were to be evaluated and the better system was to be selected. [Ref. 5:p.2]

The selection of contractors for the development phase of the DTP EW suite was initiated in July 1972. Seventy-five industrial companies indicated an interest in competing in the development of this system under the new Design-To-Price (DTP) Electronic Warfare concept. From these 75 companies, 15 were selected by the Navy as being the best qualified to manage and execute such a program from a design competition through production. These 15 received Requests for Proposals, as did an additional 28 companies who requested bid sets. Out of this potential 43 bidders, only 12

companies submitted proposals as prime contractors by the 12 November 1972 deadline. From these 12 bidders the Navy selected six to participate in the initial design competition. The Navy conducted intensive studies of the proposals utilizing various criteria, including system simulation, and selected two contractors, the Hughes Aircraft Company and the Raytheon Company, for the competitive development. After evaluation of the Technical Evaluation (TECHEVAL) and Operation Evaluation (OPEVAL) results, the estimates of military utility, and the estimated life cycle costs of the two systems, the source selection authority selected the Raytheon AN/SLQ-32 for production. [Ref. 5:p.3]

D. PROJECT MANAGEMENT

Naval Electronics Systems Command (PME-107) is the Program Manager (PM) for the AN/SLQ-32 program. The PM is the primary advocate for the program and is responsible for the technical and business/financial management of the program. He must completely understand the military need for the system and must become intimately familiar with the system as it evolves. The PM is alone responsible for the success or failure of the program and his responsibilities include planning, development, programming, acquisition,

installation, logistics and technical support of the equipment throughout the equipment throughout life cycle of the system. [Ref. 6:p.1-16]

The PM is assisted with the Integrated Logistics Support (ILS) policy and monitoring responsibilities by Navelex 08, the Life Cycle Engineering and Platform Integration Directorate. Navelex 08 conducts Logistic Assessment Reviews (LAR), which are critical reviews designed to evaluate the sufficiency of the logistics plan. Each Navelex project has an Office of the Chief of Naval Operations (OPNAV) sponsor. The OPNAV sponsor for the AN/SLQ-32 is OP-03, and they control the money allotted for the project.

Ships Parts Control Center (SPCC), Mechanicsburg, Pa. was designated as the Program Support Inventory Control Point(PSICP). The PSICP is usually designated early on in the project and they assist the PM with end item and modification spares budgeting and the necessary plans, programs and budgeted resources required to acquire all levels of initial spares and repair parts [Ref. 7:p.2-16]. Because of the unique interim support plan used on the AN/SLQ-32 program, SPCC was not involved until the decision was made to transition early to full Navy support.

The scope of the thesis deals with the logistic responsibilities of the program, in particular, the logistic support plan and the maintenance plan. The logistic and maintenance plans, and the unique aspects of the contractors supply support must be understood before proceeding with the systems' history.

E. LOGISTICS PLAN

The logistics program philosophy is to provide the least cost logistics support that is fully responsible to the life cycle requirements that are imposed by equipment design, use, mission and operational environment. To meet these responsibilities it was decided to use interim contractor support. This policy gives the responsibility of supply support to the contractor for the period up to the transition to the Navy support date. It permits the government to delay making decisions regarding stocking policy and on the range and depth allowance decisions until meaningful reliability and support requirements knowledge can be acquired through actual systems operations. [Ref. 8:p.1] The Navy supply system is provided with visibility of system stock requirements and usage and failure data during this interim support period.

The logistics plan includes the following key contractor services:

1 Production

2 Provide onboard spares

3 Operate a repair parts stock point

4 Operate as the Designated Overhaul Point (DOP)

5 Perform usage data analysis

6 Provide complete Provisioning Technical Documentation (PTD)

The contractor's spares/repair part stock point is to operate as a bonded central storage site for spares and

repair parts during the interim support period. It will receive, store, hold, issue, account for, identify, preserve, package, label, prepare for shipment, document and ship government owned support material and repair parts allowance requirements. It processes requisitions for spares and maintains inventory and summary statistics. The range and depth of the items to be carried was recommended by the contractor and approved by the PM. [Ref. 9:p.5-3] The contractors Designated Overhaul Point (DOP) was intended to be the only DOP for the whole system.It was used to repair, overhaul and assemble material turned in for repair.

The AN/SLQ-32 was approved for a five year program of interim contractor support, with an optional transition to full navy support. This five year program was divided into two phases. They were Phase 1, Contractor Support Evaluation and Phase 2, Navy Support Transition. Phase 1 was scheduled to last 41 months, until October 1980. This phase had three main objectives:

1 Measure contractor's effectiveness and determine his ability to support the system at an operational availability level of 92% and at a reasonable cost.

2 Compare the results of the contractor support evaluation with those achieveable through navy support.

3 Collect actual fleet data, required to establish realistic requirements regarding maintenance functions, stocking policy and range and depth allowances.

Phase 2, Navy Support Transition, was to commence when and if a navy support decision was reached at the end of phase 1. The second phase would last 24 months and its main

objective would be to assure a smooth and orderly transition of support functions from contractor to Navy. This would include:

1 Full range Provisioning Technical Documentation (PTD).

2 Transition of individual items to Navy support.

3 Establish Designated Overhaul Points at subvendors.

4 Residual stocks held at the contractor repair parts stock depot would be transferred to Navy stocks.

As the end of phase 1 approached several logistic problems were identified. A Logistics Review Group Audit (LRG) and an Acquisition Audit was done in September 1979. These audit boards are made up of representatives of the Naval Electronics Systems Command (NAVELEX), the Naval Material Command (NAVMAT), the Naval Supply Systems Command (NAVSUP), Ships Parts Control Center (SPCC) and the Office of the Chief of Naval Operations (OPNAV). They are responsible for reviewing and approving the adequacy of the Integrated Logistics Support (ILS) planning for the acquisition of the new weapon system. Combined these two audits had an unusually high 90 discrepancies and revealed among other things:

1 Spare parts support and availability are inadequate

2 The systems technical manuals are substandard

3 Provisioning Technical Documentation has not been purchased

4 The training of technicians was inadequate

At this time there were 56 systems operational in the fleet. The system was leading the fleet in CASREPTs and had

a combined Operational Availability (Ao) of only 63% with the (V)3 variant experiencing only 26% Ao. [Ref. 10:pp.19-22]

The results of the audits, the high CASREPT figures and the low Ao caused concern for the Vice Chief of Naval Operations (VCNO), VADM Watkins. His fleet commanders requested to continue using the AN/WLR-1, the electronic warfare system that the AN/SLQ-32 was to replace. The VCNO had OP-03, AN/SLQ-32 program sponsor, brief him on the program's problems. The VCNO discovered that a significant reason for the problem was that OP-03 drastically reduced funding to logistics and training in FY 77 through 81. OP-03 and NAVELEX had a sound logistics program on paper but OP-03 underfunded it and did not follow the plan. The VCNO accused OP-03 of "logistic dishonesty" and ordered that the Logistic Review Group (LRG) and Acquisition Audit discrepancies be corrected. [Ref. 11]

F. MAINTENANCE PLAN

The maintenance plan is based upon fast removal of defective printed circuit cards or similar shipboard replacement assemblies at the organizational level, with all repair of failed assemblies at the depot level. There is not any intermediate maintenance facility since the depot is expected to have the capability to provide a Ready For Issue (RFI) backup item immediately from onhand stock. [Ref. 9:p.3-1] The contractor is required to provide and

operate the repair depot and refurbish or repair the items that are returned by the users as Not Ready For Issue. The organizational level troubleshooting is designed to be performed by Electronic Warfare Specialists (EW) with the aid of software used in the internal programs that isolate faults in replacable assemblies.

G. EARLY TRANSITION

Phase 1 of the five year contractor support plan was scheduled to be completed in October 1982. In December 1980 because of the supply support problems of the equipment, the VCNO directed NAVSUP to begin transition supply support with a Material Support Date (MSD) of October 1982. The lack of Provisioning Technical Documentation (PTD) and the inadequate funding of the interim support program forced NAVSUP to conclude that the October 1982 MSD was not feasible. The new plan called for beginning transition in January 1983 with transfer to full Navy support in October 1985. A Transitioning Planning Team was assembled to review the current Support posture of the program, identify the actions necessary to effect a full transfer to Navy support and to develop a transition plan. The team included representatives from NAVELEX, NAVSUP, NESEC Portsmouth, NAVELEX DETACHMENT Mechanicsburg Pa., and SPCC.

The Navy decided to take control of some items and use the Navy Stock Fund (NSF) money to purchase spare parts.The NSF is a working capital fund which is used to purchase and

hold inventories of supply items. The fund provided $22.3 million in FY81 for the initial purchase of spares and $34.1 million in FY82. These purchases had lead times of two years to delivery. The fleet population of the equipment continued to grow from 56 operational units in 1980 to 173 units in 1982 with a projection of over 300 units by 1987. [Ref. 12:p.12] The timetable set up for a 1 October 1985 transition date would have conformed to standard Navy transition plans, but the AN/SLQ-32 was not a standard program. The slow transition and complete lack of supply support was unacceptable to the users in the fleet. CINCPACFLT message251915z Aug 82 to the CNO addressed the inadequate supply support that the equipment was receiving. It indicated that one half of all the systems were down with outstanding Casualty Reports (CASREPT). Average CASREPT response time increased to 45 days and many parts were just not available. At this time, even though NAVSUP was preparing the transition by contracting with Raytheon for spares and repair of repairables, the contractor was still providing the interim support. The fleets' requisitions were being sent directly to Raytheon and, because of the inadequate funding of spares, Raytheon had very few spares in stock. If an urgent CASREPT request came in for an item that was not in stock in the contractor's repair parts stock depot, Raytheon would provide parts from its production line if the line was not interrupted. If parts were still not

available the PM would often take the parts from units that were complete and already accepted by the Navy. These units are then shipped to the fleet with the parts missing, and the PM would juggle future deliveries to fill the holes. [Ref. 13:p.2] This means that if Raytheon has the part they would fill the CASREPT requisition. Most often the requisition cannot be filled and the PMs method of cannibalizing off already accepted systems, cannot work with the increasing fleet population of the equipment.

In December 1982 NAVSUP decided to step up the transition timetable. It began on a quarterly basis 1 January 1983 with transition to full Navy support on 1 October 1985. The reasoning for this decision was the earlier than planned deliveries of the 1981 buys and the large amount of Navy Stock Fund (NSF)money that would become available for FY83. [Ref. 14] The supply system was in a position where NSF money was becoming available but it could not be used by the fleet because NAVELEX was still supporting most of the spares. By transitioning to supply support in quarterly increments NAVSUP could use NSF money to contract for more spares. NAVSUP decided that because 70% of the parts were subcontracted by Raytheon and that they experienced long lead times, short term support could best be accomplished by concentrating on the contractors repair and quick turnaround of NRFI items. The plans of early transition and the large stock buys were predicated on the performance of this quick

turnaround by the contractor's DOP. SPCC fully funded a repair contract with Raytheon for the repair of the 1800 item backlog and the continued repair of NRFI items. The rapid turnaround of this material was essential to NAVSUP's efforts to providing short term support to the fleet.

Early transition was also hindered by the lack of Provisioning Technical Documentation (PTD). PTD is documentation furnished by the contractor for identification, determination of repair parts requirements, cataloging, and contractual formalization of items to be procured. The primary data used to determine initial requirements is contained in a Provisioning Parts List (PPL). The PPL contains all support items which can be disassembled, reassembled, replaced and which, when combined, constitute an end item. The PPL contains all items which are essential to the operation and maintenance of the end item and is particularly important for transition to Navy support. This data enables the Navy to establish its own organic repair facilities and assist in finding second source contractors. Provisioning Technical Documentation (PTD) was in the original contract with Raytheon but was not purchased by the PM. The PM saw the PTD as an unnecessary expense which would not be needed while the contractor was providing the supply support. Without PTD,SPCC is unable to make purchasing decisions on spares. Raytheon was asked by the Navy to do the PTD, but a problem existed in that Raytheon only

manufactured 30% of the equipment and subcontracted the remainder. Raytheon's price for just their PTD was $1.7 million, and many subvendors refused to provide their PTD. The transition team decided that Raytheon's price was too high and they decided to let NAVELEXDETMECH, Mechanicsburg do the PTD. With Raytheon's assistance and by using reverse engineering NAVELEXDETMECH was able to finish the PTD and PPL by February 1983. The Supply System used this data to make the requirements determinations decisions that led to the large full scale support buyout of spares in September 1983. [Ref. 15]

In April 1981 the AN/SLQ-32 program was put in the Detection Action Response Technique (DART) program. DART is used for weapon systems that have major support and reliability deficiencies. The troubled programs are micromanaged toward specific thresholds. Action taken under the DART program, as well as, action taken by the PM and NAVSUP to improve system effectiveness will be presented in the following chapter. Chapter III will present two measures of effectiveness, Operational Availability (Ao) and Systems Material Availability (SMA). These two measures are standards by which the Navy evaluates a weapon system's reliability, maintainability and supportability. They are also the focus of the Navys' efforts to correct the AN/SLQ-32's logistic deficiencies.

III. CORRECTIVE INITIATIVES

A. INTRODUCTION

With the advent of new technologies and the increasing complexities of systems today, combined with limited resources and reduced budgets, it is essential that all facets of a system be addressed on an integrated basis. If the results are to be effective, logistics must be considered on an integral basis with all other elements of the system. Logistics support must be initially planned and integrated into the overall system development process to assure an optimum balance between the prime equipment and its related support. This balance considers the performance characteristics of the system, the input resources required, the effectiveness of the system, and the ultimate life cycle cost. [Ref. 1:p.3] The AN/SLQ-32 program is a classic example of the problems systems effectiveness encounters when logistics is not properly planned for in a weapon system program.

This chapter will define two of the measures of effectiveness by which weapon system support is evaluated. The two measures of effectiveness, Operational Availability (Ao) and Systems Material Availability (SMA) are two official Navy standards which evaluate the systems logistic support, reliability and maintainability. They are the basis for

the initiatives that are taken to improve fleet support and are presented in this thesis by separating the different parts of their equation and then presenting the initiatives as they effect those parts. This will assist in understanding the reasons for the initiatives and also show how by attacking the different parts of the Ao equation NAVELEX and NAVSUP improved the Ao.

B. SYSTEMS EFFECTIVENESS

Systems effectiveness is often expressed as one or more figures of merit representing the extent to which the system is able to perform the intended function. The figures of merit used may vary considerably depending on the type of system and its mission requirements, and should consider the following

1 System performance parameters, such as the capacity range of frequency and accuracy of the identification capability.

2 Availability, or the measure of the degree a system is in the operable and commitable state at the start of the mission when the mission is called for at an unknown random point in time. Availability is a function of operating time (reliability) and downtime (maintainability/supportability).

3 Dependability, or the measure of the systems operating condition at one or more points during the mission, given the systems condition at the start of the mission. Dependability, like availability, is a function of operating time (reliability) and downtime (maintainability/supportability). [Ref. 1]

A combination of these measures represents the systems effectiveness aspect of total effectiveness. One can see that logistics impacts the various elements of system

effectiveness to a significant degree, particularly in the areas of availability and dependability. The effects of the type and quantity of logistics support is measured through the parameters of system effectiveness. [Ref. 1:p.48] This thesis uses the parameter of Availability and demonstrates how it is a function of reliability, maintainability and supportability.

C. MEASURES OF EFFECTIVENESS

1. Operational Availability

Operational Availability (Ao) is the probability that a system or equipment, when used under stated conditions in an actual operational environment, will operate satisfactorily when called upon. It is an official Navy measure of weapon system performance and each program has an established goal. The AN/SLQ-32 Ao goal is 92%. The equation of Ao is

$$\frac{MTBF}{MTBF + MTTR + MSRT}$$

where:
MTBF = Mean Time Between Failure
MTTR = Mean Time To Repair
MSRT = Mean Supply Response Time

The efforts to improve Ao are looked at by separating each part of the Ao equation and analyzing its contribution to the total effectiveness.

a. Mean Time Between Failures

Mean Time Between Failures (MTBF) is a reliability factor and is the mean or average time between all maintenance actions, both preventive and corrective [Ref. 1:p.48]. To improve this portion of the equation efforts were directed at improving system reliability. As part of the Detection Action Response Team (DART) the AN/SLQ-32 Reliability Improvement program was established to address individual major problem parts. The program evaluates data from the fleet, the repair depot, and the supply system to identify the high failure rate items which contribute most to fleet problems. Corrective action is taken on problem parts to perform failure analysis inorder to improve reliability and to initiate competitive procurement when it will help improve reliability. [Ref. 16:p.1] Based on this program of intensive and aggressive management of problem parts, the critical system parts were identified, prioritized and placed in a "Top Ten" moving window for possible redesign, replacement with alternate vendor product of greater reliability, development of organizational repair capability or identification of Coordinated Shipboard Allowance List (COSAL) augmentation requirements. As the part under consideration achieves an established reliability goal, it is removed from the program and another part is inducted. [Ref. 17:p.1] Three examples of this for the AN/SLQ-32 are the Traveling Wave Tube (TWT) Amplifier, the

Radar Frequency Memory Unit (RFMU) and the Radar Frequency (RF) cable assemblies. The RF cables were a major contributor to Casualty Reports (CASREPT). As a result, they are now manufactured out of a more rugged material by NESEC, Portsmouth under a work request funded by SPCC. The turn-around time for these cables is less than two weeks and CASREPT's due to this parts failure are now infrequent. The RFMU and the TWT Amplifier were two top CASREPT generators that had their reliability improved significantly by NAVELEX's efforts at designing new solid state upgrades of the items. [Ref. 12:pp.32-37] The frequency of maintenance for a given item is highly dependent on that item's reliability. As the reliability of a system increases, the frequency of maintenance will decrease. Maintenance and logistics support requirements are highly influenced by this reliability factor.

b. Mean Time to Repair

Mean Time To Repair (MTTR) is a measure of the mean corrective maintenance time. Each time that a system fails, a series of steps is required to repair or restore the system to its full operational status. These steps include failure detection, fault isolation and disassembly, on through to reassembly and repair verification. Completion of these steps for a failed item is a corrective maintenance cycle. MTTR is a composite value representing the arithmetic

average of these individual maintenance cycle times. [Ref. 1:pp.36-37] The best way to improve MTTR is by improving the system's maintainability. To do this the original maintenance philosophy was changed from depot level repair to organizational and intermediate levels of repair.

The organizational level maintenance consists of computer aided preventive and corrective maintenance. MTTR is most effected by the ease of corrective maintenance, which is performed by Electronic Warfare operator-technicians (EW) at the organizational level. The need for this corrective maintenance is detected through a combination of Built-in-Test (BIT) , System Operability Tests (SOT) and System Diagnostic Testing (SDT) programs. BIT provides continuous on-line testing of major portions of the system to monitor the status of local power supplies, RF signal levels and various operational status signals. Further isolation of the unit in which the fault resides and the type of fault present is accomplished by the operator through the exercise of on-line SOT. The SOT is a collection of off-line subtests and special functions programmed to diagnose and isolate system faults, either automatically or with maintenance manual assistance, to a single replacable assembly. These three systems along with the use of the maintenance manual isolate the faulty assembly. [Ref. 5:p.3-2] Much of the correction was done by the removal of the failed part and returning it to the depot

level for repair, recertification, and return to use. The development of Test Program Sets (TPS) and micro-miniature repair (2M) now presents opportunities for some inplace repair work done by the EWs. There has also been improvements in training of the technicians in fault isolation and repair. [Ref. 18] Training was one of the areas that was originally underfunded. As a result the EW technicians were unfamiliar with the equipment and could not correctly isolate the faults. This caused 60% of the items that were turned in for repair to be incorrectly diagnosed as Not Ready For Issue (NRFI).

c. Mean Supply Response Time

Mean Supply Response Time (MSRT) is the average time required to satisfy customer demand. One of the definitions of logistics is to have the right item, in the right place, at the right time, in the right quantity, in the right condition and at the right price. This definition describes the MSRT challenge. It is the part of the Ao equation that NAVSUP is most responsible for. In order to recover from the spares and repair funding shortfalls of FY 77-81, NAVSUP accelerated the transition to Navy support. NAVSUP's actions attempted to minimize the severity and duration of the support problems that the fleet was experiencing. Accelerating the transition enabled NAVSUP to use NSF money to purchase spares and fund the repair process. At the MSD, 1 October 1983, $134.2 million of NSF had been

invested in spares. The largest portion of those buys was made in September 1983 after NAVELEXDETMECH had provided SPCC with the Provisioning Technical Documentation (PTD). [Ref. 12:p.10]. At the time of transition there were only 1900 parts Ready For Issue (RFI)in the contractor's repair parts supply depot for turnover to SPCC. There is a two year leadtime on all of the purchased material, making the fast turnaround of Not Ready For Issue (NRFI) essential to the supply support of the active systems in the fleet. In order to dissolve the backlog of items awaiting repair and to improve turnaround time SPCC fully funded the repair of NRFI items at the Designated Overhaul Point (DOP). To further reduce the turnaround time SPCC provided Raytheon with $1.9 million for them to have an onhand inventory of piece parts [Ref. 12:p.17]. Prior to that funding Raytheon would wait and see what part came in for repair before ordering the piece parts necessary to make the repair. Another effort to reduce turnaround time was that NAVELEX established Naval Weapons Support Center, Crane, Indiana as an organic DOP. Crane currently has the capability to repair thirty-one items. Similarly, SPCC contracted with subvendors for the repair of the items they had manufactured. Previously Raytheon had done the repair.

When the system was installed in the ships, the contractor provided an Onboard Repair Parts (OBRP) kit. The kit was not very useful because only 2 of the top 10 failed

parts were provided in the kit [Ref. 12:p.2-1]. In 1984, using several years worth of usage data and the now provided PTD, SPCC provided ships with a mini-COSAL that specified the authorized onboard allowance quantities. Ships requisitioned the items that they were authorized and did not already have. These requisitions are given priority by the contractor. Another measure to improve MSRT was by approving forward positioning of stocks. Priorities are given to having stocks placed in the Mobile Logistics Support Force (MLSF) ships' Fleet Issue Load List (FILL), the Tender and Repair Ships Load List (TARSLL), and the supply centers and depots at Subic, Yokosuka and Pearl Harbor. [Ref. 19:p.14]

The quarterly Operational Availability figures for the AN/SLQ-32s' three different variants, V(1), V(2) and V(3) along with their installed fleet population are shown in Table I.

The V(3) variant is more technical and complex then the other variants and for this reason it is providing the most problems. The Ao for the V(1) and V(2) has never dropped below 61%, whereas, the V(3) Ao has yet to rise above 62%. Many of the reliability and maintainability initiatives previously addressed were attempts to positively affect the V(3) Operational Availability (Ao). The Ao figure shows an increasing percentage of availability. The V(1) and V(2) variants have almost attained the 92% Ao goal, but the V(3) variant still has to improve 30% more to reach that

TABLE I

OPERATIONAL AVAILABILITY

QTR	V(1)	(Pop)	V(2)	(Pop)	V(3)	(Pop)	Total
Mar 81	76%	(11)	82%	(30)	62%	(10)	77%
Jun	73%	(16)	92%	(38)	23%	(12)	75%
Sept	71%	(20)	83%	(40)	21%	(14)	68%
Dec	80%	(24)	76%	(45)	38%	(16)	70%
Mar 82	76%	(24)	73%	(55)	17%	(20)	66%
Jun	66%	(24)	70%	(65)	41%	(20)	64%
Sept	75%	(28)	64%	(72)	16%	(23)	58%
Dec	76%	(29)	65%	(80)	31%	(25)	61%
Mar 83	68%	(30)	68%	(90)	35%	(32)	64%
Jun	71%	(34)	82%	(96)	40%	(36)	66%
Sept	67%	(34)	72%	(102)	45%	(37)	62%
Dec *	61%	(36)	72%	(107)	50%	(41)	62%
Mar 84	66%	(37)	80%	(110)	53%	(43)	68%
Jun	68%	(39)	77%	(113)	54%	(46)	75%
Sep	78%	(40)	80%	(118)	56%	(47)	77%
Dec	83%	(43)	85%	(121)	58%	(50)	79%
Mar 85	79%	(44)	85%	(124)	60%	(50)	81%
Jun	91%	(44)	91%	(129)	62%	(52)	87%

where:
% = Ao = MTBF / MTBF + MTTR + MSRT
Pop = population = number of units intalled in the fleet
V(1), V(2), V(3) = different AN/SLQ-32 variants installed (see figure 2.1)
* = Material Support Date (MSD)

goal. The intense management of the DART program is continuing to produce good results and improve the MTBF and MTTR. This is evidenced by the fact that the Navy Material Support Date (MSD) occurred in October 1983 and the Ao figures continued to improve. Usually there is some support degradation upon transition because the dedicated attention that the PM gets from a contractor during the interim support period cannot be replicated in kind by the Navy system. The contractor support network is uniquely tuned to

program requirements and supplemented with engineering expertise. Upon transition, support must fit the Navy structure and compete for attention with other important programs [Ref. 15]. However, the DART program is maintaining the dedicated attention to the AN/SLQ-32 program that is needed to improve its' Ao. During the next several months SPCC is due to receive delivery of the large purchase of spares that was made in FY's 81 and 82. This material will fill the ships allowances and provide the supply system with an adequate inventory in the retail and wholesale stocks. This should greatly improve MSRT.

2. System Material Availability

System Material Availability (SMA) is a wholesale performance measure for the inventory control point and is defined as a percent of requisitions that are satisfied on the first pass against supply system assets [Ref. 7]. The SMA equation is :

$$100 \times \{ 1.0 - BO + DVD / DEMANDS \}$$

where:

BO = Backorders

DVD = Direct Vendor Deliveries Established

DEMANDS = requisitions to the Navy supply system for parts

The Chief of Naval Operations (CNO) goal for SMA is 85%. The SMA data shown in Table II for the An/SLQ-32 was collected

starting in October 1983 when the Navy took full supply support responsibilities.

TABLE II

SYSTEM MATERIAL AVAILABILITY

Month	Demands	SMA
Oct 83	286	54.8
Nov	323	49.5
Dec	381	59.6
Jan 84	299	67.2
Feb	247	74.5
Mar	263	84.8
Apr	309	84.8
May	381	78.0
Jun	582	83.0
Jul	599	75.6
Aug	769	54.5
Sep	702	57.6
Oct	755	71.6
Nov	468	74.4
Dec	787	75.1
Jan 85	718	70.5
Feb	688	67.0
Mar	535	72.5
Apr	777	52.7
May	723	49.5
Jun	755	82.2
Jul	604	84.9
Aug	615	82.9
Sep	619	76.8

The SMA in November 1983 was at an all time low of 49.5%. Then it increased steadily to a peak of 84.4% in February and March 1984. It remained near that value until July 1984 when it started a quick decline to another low of 54.5% in August 1984. This sudden and quick drop was in conjunction with an increase in backorders from 623 to 1480. [Ref. 19:p.15] This is the result of the fleet allowance

requisitions that were building up due to the issuing of the mini-Consolidated Shipboard Allowance Lists (COSAL).The other sudden drop off occurs in April/May 1985. This was a consequence of the Ships Parts Control Centers (SPCC) decision to no longer count all initial COSAL requisitions as demands against the system. Instead requisitions are deferred until the expected delivery date of the system stock that had been previously contracted for. Many of the items were delayed and were unable to meet the original contract delivery date. At that point, when the material became overdue, the previously deferred demands suddenly hit the system as unfilled requisitions and lowered SPCC's effectiveness figures. [Ref. 20]

All of the actions taken to improve Mean Supply Response Time (MSRT) will also improve the SMA figures. The large purchase of spares, the action to reduce turnaround time, distribution of the mini-COSAL and forward positioning are all actions that are contributing to the steady rise of SMA.

D. COST REDUCTION

By citing the initiatives taken to improve Ao and SMA we have attempted to meet the item, place, time, condition and quantity parts of the logistics definition. The one piece of that definition that is not discussed is that piece of the logistics definition that requires the needed item to be at the right price. Even though all the initiatives mentioned

were made considering fiscal constraints, there are also cost reduction measures that should be presented.

The AN/SLQ-32, like other weapon systems, has been subjected to high level scrutiny over the issue of spare parts pricing. SPCC, by working in conjunction with NAVELEX and Raytheon, has successfully timed major provisioning buys of parts to coincide with NAVELEX's AN/SLQ-32 system acquisitions. This economy of scale has brought about a 10-15% savings by having the contractor purchase in quantity from his vendors and by establishing longer production runs. Raytheon has identified over 270 vendor items that can be purchased directly from the vendors. [Ref. 19:p.27] In an attempt to breakout the parts for competition, SPCC requested that Raytheon and the subvendors provide SPCC with level III drawings for Provisioning Technical Documentation (PTD) because the PTD done previously by NAVELEXDETMECH was not detailed enough for the purpose of breakout. These detailed drawings would be used by the Navy to get other companies to manufacture the part. The reasoning being that the competition on the part would result in a lower priced part. The current manufacturers realized this so they added their estimated lost revenues on to the drawings price. The total asking price for the level III drawings was $45 million. The price was not considered to be cost effective to the Navy. Instead, in order to still attempt to breakout the parts, the Navy purchased Best Commercial Drawings

Packages (level II drawings)for $930,000. Many of the level two drawings are detailed enough to use for the breakout of parts for competitive bid. [Ref. 21]

E. SUMMARY

This chapter provides information and analysis of the Navy's actions in attacking the program's reliability, maintainability and supply support problems. The measures of effectiveness for these three areas are Operational Availability (Ao) and Systems Material Availability (SMA). There are three parts to the Ao equation, Mean Time Between Failure (MTBF), Mean Time To Repair (MTTR) and Mean Supply Response Time (MSRT). In order to better understand the initiatives taken to improve Ao, each initiative is categorized to that part of the equation that it effects. By attacking each part of the equation separately, the total result, Ao, has improved. The SMA statistics are a measure of supply support and the initiatives that effect MSRT directly influence the SMA percentages.

The acceleration of the transition to Navy supply support was necessary in order to provide a remedy for the poor support that the system was receiving. The early transition could not give a quick solution to the problem that, because of the prior logistic deficiencies, was still several years away from its goal. What the early transition

did provide was an organized, adequately funded, logistics support plan. The Ao and SMA statistics display steady improvement, but these steady improvements will become harder to attain as time goes on. The easily recognizable problems were corrected first and the results were significant, but further initiatives cannot be expected to show improvements in a linear manner. The intensified management of troubled areas must be continued and the Detection Action Response Team (DART) program is significant in providing proper visibility to the projects troubled areas.

Many of the actions that were taken would not have been necessary, had proper logistics planning been taken on early in the program. The AN/SLQ-32 program is a prime example of how poor logistics planning undermines the systems effectiveness to the user.

IV. SUMMARY AND CONCLUSIONS

A. SUMMARY

Chapter I indicated that this thesis sought to answer the question " What are the Supply Support Problems in the AN/SLQ-32 Program and How is the Navy Solving These Problems With Respect to Operational Availability and System Material Availability." The AN/SLQ-32 Program was picked for this study because it was one of the most poorly supported weapon systems in the fleet, and it offered an opportunity to research the consequences that result from poor logistic planning and management.

Chapters II and III concentrated on presenting the systems support problems and then categorizing the Navy's corrective actions according to their effect on reliability, maintainability and supportability. It is presented this way in order to emphasize the importance of logistic planning early in the systems life cycle and to highlight the roles of reliability, maintainability and supportability in providing system support effectiveness.

Chapter III presented and gave brief analysises of the initiatives that were taken by the Navy to improve the systems support. Two measures of effectiveness, Operational Availability (Ao) and Systems Material Availability (SMA) were presented as a focal point for establishing an

organized plan to improve the systems support. The different parts of the Ao equation, Mean Time Between Failure (MTBF), Mean Time To Repair (MTTR) and Mean Supply Response Time (MSRT), are defined and each is presented in relation to the support improvement initiatives that are enacted. It is demonstrated that by using this approach Ao and SMA percentages were steadily increasing towards their goals. The next section presents an analysis of the decisions that brought about the problems that are described in Chapter II.

B. ANALYSIS

1. Design-to-Cost

The AN/SLQ-32 was developed under the Design-To-Price concept. While this program was good for promoting competition and state of the art technology, it also presented problems that effected logistic support decisions. The primary goal was to meet certain specified operational requirements within the pre-established price. This gave the contractor too much liberty to make trade-offs among the factors of reliability, maintainability and supportability. It was easier and more cost effective to the contractor for him keep the equipment complex and require that he perform the depot level repair rather then spend on the research and development to simplify the equipment for shipboard repair. Similarly, in order to keep costs down, contractors were allowed to use state of the art technology and were not bound to the Navy's standardization

requirements. The standardization policy requires that contractors, whenever possible, use equipment that is already in the Navy inventory.

There are disadvantages to these two policies. There is low confidence given to a new products reliability predictions and the system has complete dependance on the contractor for repair. The contractor has little incentive to improve an item's reliability knowing he is the sole depot level repair facility. His tendency is to continue with the current maintenance plan and forgo any reliability improvements that would jeopardize the repair contract. These things cause the life cycle management of the system configuration management, supply support and equipment repair to default to the contractor. Total dependence on the contractor for these services in peacetime may be more cost effective to the government for a weapon system that is permanently based in the United States, but not for systems such as the AN/SLQ-32, that deploy and are used during wartime. The logistics of supporting these units from a single contractor would not be feasible and would degrade readiness.

2. <u>Interim Support and Transition</u>

The Logistics Plan, which called for an interim contractor support period that would be evaluated in its third year in order to determine the effectiveness of the contractors support, was not considered in the decision

making done by the PM's. Their decisions were based on the belief that the contractor would provide the life cycle support. This was one of the reasons that Provisioning Technical Documentation (PTD) was not purchased and why SPCC, was not involved in the initial phases of the program. PTD must be purchased in the early phases of the program when the contractor still has an incentive to provide it. As shown in chapter II,the lack of PTD caused problems for the transition to Navy support and also increased the eventual PTD price tag to 45 million dollars.

There was no transition planning because the PM did not recognize the realities of the environment under which the weapon system would be deployed in the fleet. It is not feasible to rely completely on contractor support for equipment that will be on deployed units. The Navy Supply System support philosophy and inventory modeling is based upon having the proper distribution of spares on deployed units and at the shore supply activities.

3. Supply Support and Repair Cycle Funding

Chapter II presented the problems caused by the lack of funding for spares and the repair cycle. This is due to the fundamental conflict that arises between the PM's needs and the logisticions needs. The PM has allegiance to his program sponsor. Their interest is in getting as many new systems into the fleet, as fast as possible. This is the

PM's major concern and is the overiding factor in any cost trade-offs that are made. [Ref. 22]

The PM's tour of duty with the program is only about three years, and he is evaluated on what he can accomplish during that time period. He is not held responsible for future problems that arise as a consequence of his early trade-off decisions. The PM wants those systems in the fleet, and is willing to accept overly optimistic reliability, maintainability and supportability predictions. As in this case, the funding of spares and repair was traded off in order to get the weapon systems delivered.

C. CONCLUSION

The trade-offs in weapon system procurement are almost always at the expense of the logistics support. The effects of these early trade-offs are felt by the end user of the equipment for several years after the system is installed and operating. As with the AN/SLQ-32, there is installed equipment that, in its initial years, has no chance of meeting its Ao goals. The accelerated transition to Navy support of the AN/SLQ-32 could not remedy this, but it did provide an organized plan for improving the systems logistics support. The thesis showed the steady improvements that were made in Ao and SMA as a result of this logistics plan, but this effort was made only after the weapon system was identified as a logistics disaster.

The solution to these logistic problems is simple in concept and not new, but difficult to comply with. The solution is to ensure that a sound logistics support plan is established early in the program and that it is adhered to and monitored. [Ref. 22] There is a stronger awareness now of the importance of proper logistics support planning. Reference 2 refers to how NAVELEX has increased the authority of their Logistics 08 Code in the weapon support programs. Logistic Review Groups (LRG's) have also been given more authority and a more significant role in the weapon systems planning. NAVSUP and SPCC are getting involved early in the logistics planning and this has enabled problems to be identified early and be solved, rather then deferring them. Reference 23, The NAVSUP Integrated Logistics Support Handbook provides guidance and check off lists to the PM's on proper logistics planning and interim support. There are still many problems with the PM's commitment to logistics, but this new awareness does provide the PM with more incentives to make trade-off decisions in favor of logistics support.

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